Department of Public Health
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SAN FRANCISCO EPIDEMIOLOGIC BULLETIN

Cryptosporidiosis in San Francisco

Cryptosporidium is a small coccidian protozoan which has been described as a cause of diarrhea in humans and animals. These organisms are capable of a complete life cycle within the same host. Infection is created by ingestion of oocysts which eventually develop beneath the intestinal epithelial cell membrane[1] to produce a self-limited, watery, non-bloody diarrhea associated with abdominal cramps, anorexia, fever and malaise. In the immunocompromised host symptoms can be both more severe and more persistent.

Epidemiology. Person-to-person and animal-to-person transmission have been documented.[2-5] Outbreaks associated with daycare have been described.[6-9] And several outbreaks associated with a contaminated public water supply have been reported.[10-13]

Water System. San Francisco's water supply comes from a remote area of Yosemite National Park in the Sierra Nevada mountains. A portion of the City is served by water delivered from the mountain reservoir, by an enclosed aqueduct, directly to users. Another part of the city receives the same water, but after storage in a local reservoir and filtration. The water distribution system is such that the elevated tanks to which the finished water is delivered prior to distribution to individual users are regularly supplied from the same sources and pressure changes in the system seldom result in "crossover" of either filtered or unfiltered water to the opposite area.

In response to the knowledge that water can transmit cryptosporidiosis and that cysts can be found in surface water, the Federal EPA has moved toward requiring filtration of public water which comes from a surface source. The California EPA already has regulations in place which require this filtration.

Background. In 1985 the Public Health Laboratory examined over 2000 stool specimens from San Francisco men for cryptosporidium, 500 in a screening program for enteric pathogens in gay men (STED) and 1500 in the San Francisco Men's Health Study. One patient was positive in the Men's Health Study and none in the STED screening. Whether or not these men had symptoms is unknown.

The San Francisco Water Department has regularly tested water for cryptosporidium since 1989. The results of these test consistently show levels of cysts averaging less than 1 cyst/100 liters. In one study the ID_{50} for cryptosporidium in healthy individuals was shown to be 132 cysts.[14]

Cryptosporidiosis is one of the AIDS defining diagnoses. San Francisco has an AIDS incidence among the very highest in the nation and one hundred or more of cryptosporidiosis cases are reported each year. Thus this disease constitutes a significant public health problem. This study was undertaken to examine whether water filtration or lack thereof plays a role in this disease burden.

METHODS

All cases of cryptosporidiosis reported from 1989, when the disease became reportable, through the first quarter of 1993 were included. In addition a number of cases seen at San Francisco General Hospital but not previously reported were included. Cases were from 1986 through first quarter 1993. All included cases were matched to the AIDS registry to discover dual diagnoses. Five hundred

forty-eight cases of cryptosporidiosis were included but fifteen had unknown addresses for a total of 533 cases for analysis. Cases were lumped into a single unit without regard to time of occurrence in order to create a group large enough to analyze by census tract. Population figures are from the 1990 census.

Military census tracts and population were excluded from this analysis since regular disease reporting is not done by the military. The military population is 9,224, 4509 with unfiltered water (Treasure Island) and 4715 not supplied with SF water (Presidio). The census tracts of the City were grouped as receiving only filtered, 90% filtered, 75% filtered, only unfiltered, 90% unfiltered, 75% unfiltered, mixed filtered and unfiltered water, according to a map and estimates of the proportion of the area of each tract included on the map as having filtered water (Figure 1). The water supply and distribution system in San Francisco is such that it is reasonable to assume that those areas labeled as receiving filtered water do receive only filtered water and vice versa, that is, water pressure changes do not result in significant changes of filtration status of the water delivered to these areas. An attempt was made to deal with the confounding introduced by AIDS by setting cryptosporidiosis against a denominator of the total of AIDS cases ever reported in the census tract groups.

RESULTS

Of the 533 cases 4 were of unknown sex. Of the remaining cases, 487 or 92% were male. The age of 12 cases was unknown. Of the remaining cases, 12 or 2% were less than 10 years old. Ethnic/racial origin was unknown for 414 or 78% of cases. Fifteen percent (80 cases) were white non-Latino; 6%, or 31 cases, were Latino. There were 4 black and 4 Asian cases. With the exception of 3 Asian children, the ethnic/racial origin of all children was unknown.

Of the total 533 cases, 445 or 84% were known to have AIDS; 5 of these were women. The immune status of the remaining 88 is unknown.

Table 1 shows the occurrence of cryptosporidiosis per 100,000 population in the filtered and unfiltered census tract groups. Cryptosporidiosis was about three times as likely to occur in areas which received mostly filtered water as those which received mostly unfiltered water, with the mixed area falling between the two in occurrence. A total of 115,304 people live in census tracts that are at least 75% filtered, 16% of the total population. Census tracts defined as having mixed filtered and unfiltered water account for 110,623 people, another 16%. The total non-military population of San Francisco was 720,376 in the 1990 census.

Table 2 shows the occurrence of cryptosporidiosis using AIDS cases as the denominator. The same general relationship between filtered and unfiltered areas is shown, however the mixed area seems to have the same occurrence as the filtered areas.

Table 3 shows the proportion of AIDS cases with cryptosporidiosis to total AIDS cases in the filtered area compared to the unfiltered areas. AIDS patients who live in areas that receive filtered water are twice as likely to get cryptosporidiosis as AIDS patients whose homes received unfiltered water.

DISCUSSION

With more than 500 cases in about 6 years, cryptosporidiosis constitutes a public health problem in San Francisco, particularly when considering that the overwhelming majority of these cases have AIDS, a circumstance which transforms a usually self limited disease to one that is destructive of the quality of life, at best, to one that is life threatening, at worst.

This was an ecologic study with all the problems associated with that type of study. There is no information about what the actual source of drinking water is for any of these cases, or indeed, the whole population of the City. The assumption in this study, that tap water at home is the major source of water consumption, is recognized as tenuous.

With the exception of those census tracts that are 100% filtered or unfiltered, the assignment of status to the tract on the basis of map area bears an undetermined relationship to the proportion of population of that tract which actually receives filtered or unfiltered water. The assignment of all AIDS cases which ever occurred in a census tract as a denominator overestimates the prevalence of

AIDS by an undetermined amount which may not be equally distributed to all census tracts around the city.

The fact that only 12 children and 27 females are included in the data set raises questions about the completeness of case finding. There is most likely a diagnosing bias, patients who are not immune compromised may not get laboratory diagnosis. There may also be a reporting bias, in the private sector non-AIDS patients are not reported.

Nevertheless, the findings of the study show a consistency which, while unexpected, is difficult to dismiss. The occurrence of cryptosporidiosis is 2-4 times higher in areas with filtered water than those with unfiltered water no matter what portion of the city is used for analysis and regardless of whether AIDS cases or total population is used as denominator. This adds to the conclusion that water is not the important factor in cryptosporidiosis transmission in San Francisco.

Furthermore, there is evidence that this is not simply a phenomenon that the water is infectious only to AIDS patients since there is a two fold difference in occurrence in AIDS patients between the filtered and non-filtered areas of the City.

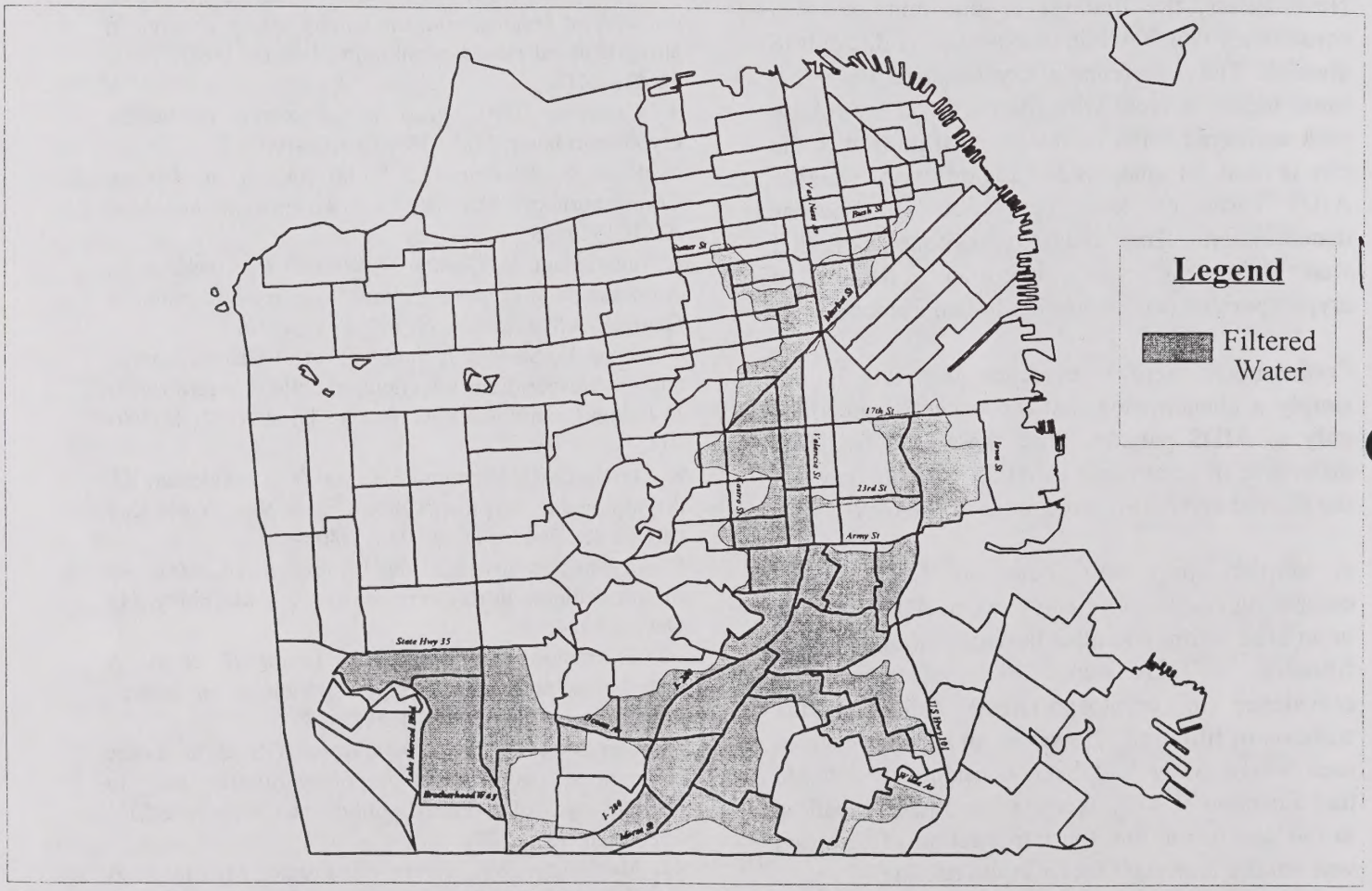
A similar study was done in Los Angeles comparing cryptosporidiosis rates in AIDS patients in an area before and after the installation of water filtration.[15] There was a 20% decrease in the prevalence of cryptosporidiosis following the addition of filtration. However, an adjacent control area where water had been continuously filtered had a decline of 47% over the same period leading to the conclusion that the introduction of filtration was not the important factor in the decline.

The combination of the consistently very low levels of oocysts in the water and the findings of this study suggest that it is very unlikely that San Francisco water is a significant source of the cryptosporidiosis in the City. It is important to examine other routes of transmission in order to introduce effective interventions. Shigella, hepatitis A, and E. histolytica are fecal-orally transmitted and have low infecting doses, similar to cryptosporidium. All of these organisms have been shown to have sexual transmission. It is therefore reasonable to postulate sexual transmission for cryptosporidiosis. Measures to protect against this route of infection are probably much more important to prevent cryptosporidiosis than efforts to boil or filter San Francisco tap water.

References

1. Janoff EN, Reller LB. Cryptosporidium species, a protean protozoan J Clin Microb 1987; 25:967-975
2. Current W, Reese N, Ernest J, et al. Human cryptosporidiosis in immunocompetent and immunodeficient persons. NEJM 1983; 308: 1252-1257
3. Miron D, Kenes J, Dagan R, Calves as a source of an outbreak of cryptosporidiosis among young children in an agricultural closed community. Ped Inf Dis J. 1991; 10:438-441
4. Casemore DP. Sheep as a source of human cryptosporidiosis. J Inf 1989; 19: 101-104
5. Reif JS, Wimmer L, Smith JA, et al. Human Cryptosporidiosis associated with an epizootic in calves. AJPH 1989; 79:1528-1530
6. Tangermann R, Gordon S, Wiesner P, Kreckman L. An outbreak of cryptosporidiosis in a day-care center in Georgia. AM J Epidemiol. 1991; 133:471-6
7. Addiss D, Stewart J, Finton R, et al Giardia lamblia and Cryptosporidium infections in child day-care center in Fulton County, Georgia. Ped Inf Dis J. 1991; 10:907-911.
8. Crawford FG, Vermund SH, Ma JY, Deckelbaum RJ. Asymptomatic cryptosporidiosis in a New York Day care center. Ped Inf Dis J 1988; 7:806-7.
9. Cryptosporidiosis: a newly recognized cause of diarrheal illness in day care centers. CA Morbidity #41 Oct 19, 1984
10. D'Antonio RG, Winn RE, Taylor JP et al. A waterborne outbreak of cryptosporidiosis in normal hosts. Ann Int Med 1985; 103:886-888
11. Hayes EB, Matte TD, O'Brien TR, et al. Large community outbreak of cryptosporidiosis due to contamination of a filtered public water supply. NEJM 1989; 320: 1372-1376
12. MacKenzie WR, Hoxie NJ, Proctor ME, et al. A massive outbreak in Milwaukee of cryptosporidium infection transmitted through the public water supply. NEJM 1994; 33:161-167
13. CD Summary. A large outbreak of cryptosporidiosis in Jackson County. OR Hlth Div. 1992; 41-14: July 14, 1992
14. Dupont HL, Chappell CL, Sterling C et al. Infectivity of Cryptosporidium parvum for adult humans. NEJM 1995; 332:855-859
15. Sorvillo F, Lieb LE, Nahlen B, et al. Municipal drinking water and cryptosporidiosis among persons with AIDS in Los Angeles County. Epidemiol Infect. 1994; 113:313-320

Figure 1. Areas of San Francisco Served with Filtered Water



Source: San Francisco Department of Public Health, Bureau of Epidemiology, Disease Control and AIDS.

TABLE 1

Occurrence of cryptosporidiosis per 100,000 population

	100%		≥ 90%		≥ 75%		Mixed	
	cases	rate	cases	rate	cases	rate	cases	rate
FILTERED	115	144	144	147	182	158		
							96	87
UNFILTERED	142	35	229	50	254	52		

TABLE 2

Occurrence of cryptosporidiosis per AIDS cases

	100%		≥ 90%		≥ 75%		Mixed	
	cases	rate	cases	rate	cases	rate	cases	rate
FILTERED	115	4865	144	4444	182	4429		
							96	4449
UNFILTERED	142	2876	229	3044	254	3130		

TABLE 3

Occurrence of cryptosporidiosis in AIDS patients

	100%		≥ 90%		≥ 75%		Mixed	
	cases	rate	cases	rate	cases	rate	cases	rate
FILTERED	98	4146	121	2626	155	3772		
							74	3429
UNFILTERED	118	2383	190	2526	212	2612		

San Francisco Department of Public Health
Fact Sheet

What you should know about
CRYPTOSPORIDIOSIS
(crip-to-spor-id-i-o-sis)

What is cryptosporidiosis?

Cryptosporidiosis is a disease of the intestinal tract caused by the parasite *Cryptosporidium* parvum. It has only been know to cause disease in humans since 1976. *Cryptosporidium* lives in a protective shell called an oocyst. This enables it to survive many environmental conditions and be resistant to disinfection.

How is cryptosporidiosis spread?

Cryptosporidiosis is spread by putting something in the mouth that has been contaminated with the stool of an infected person or animal. It can be spread in the following ways:

- ✓ drinking contaminated water
- ✓ swallowing water while swimming in contaminated waters
- ✓ contact with the stool of infected animals (e.g., pets and farm animals)
- ✓ contact with the stool of infected persons (e.g., changing diapers, sexual practices)
- ✓ eating contaminated foods (rarely happens)
- ✓ hand-to-mouth transfer of oocysts from surfaces that may have become contaminated with infected stool (surface where diapers are changed)

San Francisco drinking water has extremely low levels of Cryptosporidium in it and does not pose any risk to the general public. Outbreaks of disease have occurred in other areas from contamination of the water by unusual circumstances such as large spring water runoff. If a situation such as this arose water customers could expect to be notified and given information on what to do.

What are the symptoms of cryptosporidiosis?

Two to 10 days after infection by the parasite, symptoms may appear. Although some persons may not have symptoms, others have: watery diarrhea, headache, abdominal cramps, nausea, vomiting, low-grade fever. These symptoms may lead to weight loss and dehydration.

In otherwise healthy persons, these symptoms usually last 1 to 2 weeks, at which time the immune system is able to stop the infection. In persons with a suppressed immune system, the infection may continue and become life-threatening. Examples of persons with a suppressed immune system are individuals who have AIDS, persons who recently had an organ or bone marrow transplant, or persons who are undergoing chemotherapy.

Is there a treatment for cryptosporidiosis?

There is no definitive treatment for cryptosporidiosis. For persons with a normal immune system, the disease goes away on its own. For persons with AIDS, some drugs may treat the disease or at least relieve symptoms.

What steps can taken to prevent cryptosporidiosis?

- Avoid swallowing lake, river and swimming pool waters.
- Avoid fecal contamination of the hands or mouth during sex.
- If you have cryptosporidiosis yourself, wash your hands after using the toilet to prevent spreading the infection.
- If you are a caregiver of patients with cryptosporidiosis, wash your hands after bathing patients, emptying bedpans, changing soiled linen, or otherwise possibly coming in contact with the stools of patients.
- Wash your hands after using the toilet or changing diapers and before handling food. If you use gloves during diaper changing, change them between each child.
- Wash your hands after gardening or other contact with soil.

The decision as to whether to take any additional precautions rests with the individual.

If you have severe immune suppression (for example AIDS with a CD 4 count < 200) you may wish to further reduce your risk by treating your drinking water. This can be done by purchasing distilled water (not just bottled), boiling your water for 1 minute, or filtering it. Home filters must be those which state that they remove particles 1 micron (μ) or larger (not filters which claim to only remove lead, chlorine or tastes). Water filteration devices must be maintained strictly according to the manufacturer's instructions or they may aggravate rather than alleviate the risk.

Remember, if you choose to drink treated water you must also do so away from home. You should avoid ice and unheated beverages prepared from tap water such as fountain soft drinks (from machines, which dispense into a cup) and any juice prepared from concentrate. Coffee and tea are safe, except iced tea not prepared with boiling water may not be safe.

If you suspect that you have cryptosporidiosis...

See you physician as soon as possible, especially if your immune system is suppressed, so that the disease can be properly identified and monitored.

For more information about....

Cryptosporidiosis: Call the San Francisco Department of Public Health of Communicable Disease Control at 554-2830

Local drinking water quality: San Francisco Water Department at: 872-5954

July 1995

Adapted from CDHS Fact Sheet

CITY AND COUNTY OF SAN FRANCISCO

REPORTED CASES OF CERTAIN NOTIFIABLE DISEASES

9 WEEK PERIOD ENDING 4/29/95

POPULATION 1990 CENSUS: 723,959

DISEASE	CASES REPORTED WEEKS 9 THROUGH 17			TOTAL CASES REPORTED TO DATE		
	1993	1994	1995	1993	1994	1995
AIDS	1,049	503	373	2,387	930	661
AMEBIASIS	38	45	56	73	83	96
CAMPYLOBACTERIOSIS	89	88	61	190	156	142
CHANCROID	0	0	0	0	0	0
CHLAMYDIAL INFECTIONS	634	439	337	845	785	662
GIARDIASIS	65	46	85	93	115	148
GONORRHEA	497	367	317	783	643	576
H. INFLUENZAE INVASIVE DISEASE	6	1	3	9	2	4
HEPATITIS Type A	42	32	73	78	52	128
HEPATITIS Type B	12	13	12	23	22	19
HEPATITIS Non A - Non B	1	0	0	3	0	0
LISTERIOSIS	4	0	2	4	1	5
LYME DISEASE	0	0	0	1	0	0
MALARIA	5	3	1	6	4	5
MEASLES	1	2	0	1	2	0
MENINGOCOCCAL INFECTIONS	1	0	2	1	3	5
PELVIC INFLAMMATORY DISEASE	43	21	11	64	48	32
PERTUSSIS	0	0	4	0	1	5
RUBELLA	0	0	1	0	0	2
SALMONELLOSIS	47	22	14	71	48	43
SHIGELLOSIS	34	24	34	68	54	77
SYPHILIS, Total	28	17	15	53	30	19
SYPHILIS, Primary & Secondary	10	8	7	22	15	9
TUBERCULOSIS	62	55	49	119	96	83
TYPHOID FEVER	0	1	3	0	1	3
TOTAL DEATHS REPORTED THIS PERIOD	1,361	1,426		2,792	2,668	
Deaths from pneumonia and influenza	36	171		99	322	
Medical Examiner cases	240	270		505	560	
Drug-related cases	40	54		95	88	
Cocaine-related cases	19	27		50	34	

CITY AND COUNTY OF SAN FRANCISCO
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